

CLAIMS

What is claimed is:

1. A method for sending a multidimensional database query to one or more data servers, the multidimensional database query including a grid having one or more rows and one or more columns, an action range, and an operation, the method comprising:

creating a row tree structure, said row tree structure representing title and header rows in the query grid;

creating a column tree structure, said column tree structure representing header columns in the query grid;

performing the operation on the row tree structure and the column tree structure; and

splitting the query grid using the row tree structure and the column tree structure.

2. The method of claim 1, wherein said creating a row tree structure includes assigning members of the same row of the query grid as siblings of each other in the row tree structure.

3. The method of claim 2, wherein said creating a row tree structure further includes assigning members of a row in the query grid as children of members of a previous row in the query grid in the tree structure.

4. The method of claim 3, wherein said assigning members of a row in the query grid as children includes, for each member in a row in the query grid:

assigning said member as a child of a closest member in said previous row; and

wherein if two members in said previous row are equidistant, said closest member is the first of said two members.

5. The method of claim 1, wherein each of one or more nodes in said row tree structure contains row and column information regarding a corresponding cell in the query grid.

6. The method of claim 1, wherein said creating a column tree structure includes assigning members of the same column of the query grid as siblings of each other in the column tree structure.

7. The method of claim 6, wherein said creating a column tree structure further includes assigning members of a column in the query grid as children of members of a previous column in the query grid in the tree structure.

8. The method of claim 7, wherein said assigning members of a column in the query grid as children includes, for each member in a column in the query grid:

assigning said member as a child of a closest member in said previous column; and

wherein if two members in said previous column are equidistant, said closest member is the first of said two members.

9. The method of claim 1, wherein each of one or more nodes in said column tree structure contains row and column information regarding a corresponding cell in the query grid.

10. The method of claim 1, further comprising deleting extra information from the query grid.
11. The method of claim 10, wherein said extra information includes data cells.
12. The method of claim 10, wherein said extra information includes alias information.
13. The method of claim 10, wherein said extra information includes repeated member names.
14. The method of claim 10, wherein said extra information includes external text or labels.
15. The method of claim 10, further comprising modifying the action range in light of said deletion.
16. The method of claim 14, wherein said deleted external texts or labels are saved in a data structure with corresponding row and column information.
17. The method of claim 1, further comprising checking the row and column trees to ensure all basic dimensions are represented in the trees.
18. The method of claim 17, wherein dimensions may be represented in the trees directly or through an associated attribute dimension.

19. The method of claim 17, further comprising adding any basic dimensions to the trees that are not represented in the trees.

20. The method of claim 1, wherein said performing the operation includes:  
traversing said row tree structure in pre-order to determine if any of the nodes is in the action range;

for each node in the action range:

querying related members of the member corresponding to the node using metadata, said querying based on the operation; and

inserting or deleting nodes of said row tree structure based on results of said querying while maintaining correct relationships in the row tree structure.

21. The method of claim 20, wherein said performing the operation further includes:  
traversing said column tree structure in pre-order to determine if any of the nodes is in the action range;

for each node in the action range:

querying related members of the member corresponding to the node using metadata, said querying based on the operation; and

inserting or deleting nodes of said column tree structure based on results of said querying while maintaining correct relationships in the column tree structure.

22. The method of claim 21, further comprising changing row and column counts of nodes in said row tree structure and said column tree structure to represent said insertions and/or deletions.

23. The method of claim 1, wherein said splitting the query grid includes splitting the query grid based upon a user-provided basis for splitting.

24. The method of claim 1, wherein said user-provided basis for splitting is approximately equal sized number of sub-grids based on a fraction provided by the user.

25. The method of claim 1, wherein said user-provided basis for splitting is a number of lines per sub-grid.

26. The method of claim 1, wherein said user-provided basis for splitting is implicit based on the number of lines that can be displayed at one time on a display.

27. The method of claim 23, wherein said splitting the query grid based upon a user-provided basis for splitting includes:

traversing said row tree structure to get the number of rows and columns required by the header rows of a resulting grid;

traversing said column tree structure to get the number of rows and columns required by the header columns of a resulting grid;

traversing said row tree structure to create a header row grid;

splitting said query grid into sub-grids based on said user-provided basis for splitting, said number of rows and columns required by the header rows of a resulting grid, said number of rows and columns required by the header columns of a resulting grid, and a number of rows of said header row grid; and

appending said header row grid to the top of each of said sub-grids.

28. The method of claim 27, wherein said traversing said row tree structure to get the number of rows and columns required by the header rows of a resulting grid includes:

counting a number of siblings available at each level of said row tree structure;

counting a number of levels of said row tree structure; and

wherein said number of rows required by the header rows of a resulting grid is equal to said number of levels of said row tree structure, and said number of columns required by the header rows of a resulting grid is equal to a maximum number of siblings available at any one level of said row tree structure.

29. The method of claim 27, wherein said traversing said column tree structure to get the number of rows and columns required by the header columns of a resulting grid includes:

counting a number of siblings available at each level of said column tree structure;

counting a number of levels of said column tree structure; and

wherein said number of columns required by the header columns of a resulting grid is equal to said number of levels of said column tree structure, and said number of rows required by the header columns of a resulting grid is equal to a maximum number of siblings available at any one level of said column tree structure.

30. The method of claim 27, wherein said number of rows and columns required by the header rows of a resulting grid and said number of rows and columns required by the header columns of a resulting grid make up a size for said resulting grid.

31. The method of claim 27, wherein said traversing said row tree structure to create a header row grid includes:

creating a header row grid of size (number of rows required by the header rows of a resulting grid, number of columns required by the header rows of a resulting grid + number of columns required by the header columns of a resulting grid); and

filling columns of said header row grid with members corresponding to nodes in said row tree structure, said filling including ensuring that any columns of said header row grid that would not be filled by members corresponding to nodes in said row tree structure remain blank and begin on the leftmost side of said header row grid.

32. The method of claim 1, further comprising:

transmitting said split query grids to a data server for data retrieval one at a time.

33. The method of claim 1, further comprising:

transmitting said split query grids to multiple data servers simultaneously for data retrieval.

34. The method of claim 1, further comprising:

receiving resultant split grids from one or more data servers;

parsing said resultant split grids to identify  $n$  header rows;

for each resultant split grid after the first:

discarding the first  $n$  rows of said resultant split grid; and

appending said remainder of said resultant split grid to said first resultant split grid.

35. The method of claim 34, wherein said parsing said resultant split grid includes:

traversing each resultant split grid row-wise until a first data item is encountered; and

wherein  $n$  is equal to the number of rows traversed until said first data item is encountered.

36. The method of claim 1, further comprising:

saving said row tree structure and said column tree structure for later use.

37. An apparatus for sending a multidimensional database query to one or more data servers, the multidimensional database query including a grid having one or more rows and one or more columns, an action range, and an operation, the apparatus comprising:

a row tree structure creator;

a column tree structure creator;

a row tree structure column tree structure operation performer coupled to said row tree structure creator and to said column tree structure creator; and

a query grid splitter coupled to said row tree structure column tree structure operation performer.



38. The apparatus of claim 37, wherein said row tree structure creator includes a same row member sibling assigner.

39. The apparatus of claim 38, wherein said row tree structure creator further includes a previous row member child assigner.

40. The apparatus of claim 37, further comprising a tree structure node row and column information maintainer coupled to said row tree structure creator and to said column tree structure creator.

41. The apparatus of claim 37, wherein said column tree structure creator includes a same column row member sibling assigner.

42. The apparatus of claim 41, wherein said column tree structure creator further includes a previous column member child assigner.

43. The apparatus of claim 37, further comprising an query grid extraneous information deleter coupled to said row tree structure creator and to said column tree structure creator.

44. The apparatus of claim 43, further comprising an action range modifier coupled to said query grid extraneous information deleter.

45. The apparatus of claim 44, further comprising a deleted external text or label data structure saver coupled to said query grid extraneous information deleter.

46. The apparatus of claim 37, further comprising a basic dimension column and row tree structure verifier coupled to said row tree structure creator and to said column tree structure creator.

47. The apparatus of claim 46, further comprising a missing dimension adder coupled to said basic dimension column and row tree structure verifier.

48. The apparatus of claim 37, wherein said row tree structure column tree structure operation performer includes:

- an action range row tree structure traverser;

- a node related member operation queryer coupled to said action range row tree structure traverser; and

- a node creation and deletion module coupled to said node related member operation queryer.

49. The apparatus of claim 48, wherein said row tree structure column tree structure operation performer includes:

- an action range column tree structure traverser;

- said node related member operation queryer coupled to said action range column tree structure traverser; and

said node creation and deletion module coupled to said node related member operation querier.

50. The apparatus of claim 49, further comprising a row and column count changer coupled to said row tree structure column tree structure operation performer.

51. The apparatus of claim 37, wherein said query grid splitter includes:

a number of rows and columns required by header rows row tree structure traverser;

a number of rows and columns required by header columns column tree structure traverser;

a header row grid creator;

a query grid subgrid splitter coupled to said number of rows and columns required by header rows row tree structure traverser and to said number of rows and columns required by header columns column tree structure traverser; and

a header row grid appender coupled to said query grid subgrid splitter and to said header row grid creator.

52. The apparatus of claim 51, wherein said number of rows and columns required by header rows row tree structure traverser includes:

a number of siblings at each row tree structure level counter; and

a number of row tree structure levels counter.

53. The apparatus of claim 51, wherein said number of rows and columns required by header columns column tree structure traverser includes:

a number of siblings at each column tree structure level counter; and

a number of column tree structure levels counter.

54. The apparatus of claim 37, further comprising:

a resultant split grids receiver;

a resultant split grids *n* header row parser coupled to said resultant split grids receiver;

a resultant split grids *n* header row discarder coupled to said resultant split grids *n* header row parser; and

a resultant split grids *n* header row appender coupled to said resultant split grids *n* header row discarder.

55. The apparatus of claim 37, further comprising a tree structures saver coupled to said row tree structure column tree structure operation performer.

56. An apparatus for sending a multidimensional database query to one or more data servers, the multidimensional database query including a grid having one or more rows and one or more columns, an action range, and an operation, the apparatus comprising:

means for creating a row tree structure, said row tree structure representing title and header rows in the query grid;

means for creating a column tree structure, said column tree structure representing header columns in the query grid;

means for performing the operation on the row tree structure and the column tree structure; and

means for splitting the query grid using the row tree structure and the column tree structure.

57. The apparatus of claim 56, wherein said means for creating a row tree structure includes means for assigning members of the same row of the query grid as siblings of each other in the row tree structure.

58. The apparatus of claim 57, wherein said means for creating a row tree structure further includes means for assigning members of a row in the query grid as children of members of a previous row in the query grid in the tree structure.

59. The apparatus of claim 58, wherein said means for assigning members of a row in the query grid as children includes, for each member in a row in the query grid:

means for assigning said member as a child of a closest member in said previous row; and

wherein if two members in said previous row are equidistant, said closest member is the first of said two members.

60. The apparatus of claim 56, wherein each of one or more nodes in said row tree structure contains row and column information regarding a corresponding cell in the query grid.

61. The apparatus of claim 56, wherein said means for creating a column tree structure includes means for assigning members of the same column of the query grid as siblings of each other in the column tree structure.

62. The apparatus of claim 61, wherein said means for creating a column tree structure further includes means for assigning members of a column in the query grid as children of members of a previous column in the query grid in the tree structure.

63. The apparatus of claim 62, wherein said means for assigning members of a column in the query grid as children includes, for each member in a column in the query grid:

means for assigning said member as a child of a closest member in said previous column;  
and

wherein if two members in said previous column are equidistant, said closest member is the first of said two members.

64. The apparatus of claim 56, wherein each of one or more nodes in said column tree structure contains row and column information regarding a corresponding cell in the query grid.

65. The apparatus of claim 56, further comprising means for deleting extra information from the query grid.

66. The apparatus of claim 65, wherein said extra information includes data cells.

67. The apparatus of claim 65, wherein said extra information includes alias information.
68. The apparatus of claim 65, wherein said extra information includes repeated member names.
69. The apparatus of claim 65, wherein said extra information includes external text or labels.
70. The apparatus of claim 65, further comprising means for modifying the action range in light of said deletion.
71. The apparatus of claim 69, wherein said deleted external texts or labels are saved in a data structure with corresponding row and column information.
72. The apparatus of claim 56, further comprising means for checking the row and column trees to ensure all basic dimensions are represented in the trees.
73. The apparatus of claim 72, wherein dimensions may be represented in the trees directly or through an associated attribute dimension.
74. The apparatus of claim 72, further comprising means for adding any basic dimensions to the trees that are not represented in the trees.

75. The apparatus of claim 56, wherein said means for performing the operation includes:  
means for traversing said row tree structure in pre-order to determine if any of the nodes is in the action range;  
for each node in the action range:  
means for querying related members of the member corresponding to the node using metadata, said querying based on the operation; and  
means for inserting or deleting nodes of said row tree structure based on results of said querying while maintaining correct relationships in the row tree structure.

76. The apparatus of claim 75, wherein said means for performing the operation further includes:  
means for traversing said column tree structure in pre-order to determine if any of the nodes is in the action range;  
for each node in the action range:  
means for querying related members of the member corresponding to the node using metadata, said querying based on the operation; and  
means for inserting or deleting nodes of said column tree structure based on results of said querying while maintaining correct relationships in the column tree structure.

77. The apparatus of claim 76, further comprising means for changing row and column counts of nodes in said row tree structure and said column tree structure to represent said insertions and/or deletions.



78. The apparatus of claim 56, wherein said means for splitting the query grid includes means for splitting the query grid based upon a user-provided basis for splitting.

79. The apparatus of claim 56, wherein said user-provided basis for splitting is approximately equal sized number of sub-grids based on a fraction provided by the user.

80. The apparatus of claim 56, wherein said user-provided basis for splitting is a number of lines per sub-grid.

81. The apparatus of claim 56, wherein said user-provided basis for splitting is implicit based on the number of lines that can be displayed at one time on a display.

82. The apparatus of claim 78, wherein said means for splitting the query grid based upon a user-provided basis for splitting includes:

means for traversing said row tree structure to get the number of rows and columns required by the header rows of a resulting grid;

means for traversing said column tree structure to get the number of rows and columns required by the header columns of a resulting grid;

means for traversing said row tree structure to create a header row grid;

means for splitting said query grid into sub-grids based on said user-provided basis for splitting, said number of rows and columns required by the header rows of a resulting grid, said

number of rows and columns required by the header columns of a resulting grid, and a number of rows of said header row grid; and

means for appending said header row grid to the top of each of said sub-grids.

83. The apparatus of claim 82, wherein said means for traversing said row tree structure to get the number of rows and columns required by the header rows of a resulting grid includes:

means for counting a number of siblings available at each level of said row tree structure;

means for counting a number of levels of said row tree structure; and

wherein said number of rows required by the header rows of a resulting grid is equal to said number of levels of said row tree structure, and said number of columns required by the header rows of a resulting grid is equal to a maximum number of siblings available at any one level of said row tree structure.

84. The apparatus of claim 82, wherein said means for traversing said column tree structure to get the number of rows and columns required by the header columns of a resulting grid includes:

means for counting a number of siblings available at each level of said column tree structure;

means for counting a number of levels of said column tree structure; and

wherein said number of columns required by the header columns of a resulting grid is equal to said number of levels of said column tree structure, and said number of rows required by the header columns of a resulting grid is equal to a maximum number of siblings available at any one level of said column tree structure.

85. The apparatus of claim 82, wherein said number of rows and columns required by the header rows of a resulting grid and said number of rows and columns required by the header columns of a resulting grid make up a size for said resulting grid.

86. The apparatus of claim 82, wherein said means for traversing said row tree structure to create a header row grid includes:

means for creating a header row grid of size (number of rows required by the header rows of a resulting grid, number of columns required by the header rows of a resulting grid + number of columns required by the header columns of a resulting grid); and

means for filling columns of said header row grid with members corresponding to nodes in said row tree structure, said filling including ensuring that any columns of said header row grid that would not be filled by members corresponding to nodes in said row tree structure remain blank and begin on the leftmost side of said header row grid.

87. The apparatus of claim 56, further comprising:

means for transmitting said split query grids to a data server for data retrieval one at a time.

88. The apparatus of claim 56, further comprising:

means for transmitting said split query grids to multiple data servers simultaneously for data retrieval.

89. The apparatus of claim 56, further comprising:
- means for receiving resultant split grids from one or more data servers;
  - means for parsing said resultant split grids to identify  $n$  header rows;
  - for each resultant split grid after the first:
    - means for discarding the first  $n$  rows of said resultant split grid; and
    - means for appending said remainder of said resultant split grid to said first resultant split grid.
90. The apparatus of claim 89, wherein said means for parsing said resultant split grid includes:
- means for traversing each resultant split grid row-wise until a first data item is encountered; and
  - wherein  $n$  is equal to the number of rows traversed until said first data item is encountered.
91. The apparatus of claim 56, further comprising:
- means for saving said row tree structure and said column tree structure for later use.
92. A program storage device readable by a machine, tangibly embodying a program of instructions executable by the machine to perform a method for sending a multidimensional database query to one or more data servers, the multidimensional database query including a grid having one or more rows and one or more columns, an action range, and an operation, the method comprising:

creating a row tree structure, said row tree structure representing title and header rows in the query grid;

creating a column tree structure, said column tree structure representing header columns in the query grid;

performing the operation on the row tree structure and the column tree structure; and

splitting the query grid using the row tree structure and the column tree structure.